

What is claimed is:

1. A multiplex laser light source comprising:

a plurality of semiconductor lasers;

a single multi-mode optical fiber; and

a light-collecting optics system for collecting laser beams emitted from said plurality of semiconductor lasers and then coupling the collected laser beams to said multi-mode optical fiber.

2. The multiplex laser light source as set forth in claim 1, wherein

said plurality of semiconductor lasers are disposed so that their light-emitting points are arranged in a row in a first direction parallel to their active layers; and

said light-collecting optics system comprises

a plurality of collimator lenses, each having a first aperture diameter in said first direction and a second aperture diameter larger than said first aperture diameter in a second direction perpendicular to said first direction, and provided so that they correspond to each of said plurality of said semiconductor lasers, and

a collective lens for collecting said plurality of laser beams collimated by said plurality of collimator lenses and then converging the collimated laser beams on an end face of said multi-mode optical fiber.

3. The multiplex laser light source as set forth in claim 2, wherein said plurality of collimator lenses are formed

integrally with one another and are constructed as a lens array.

4. The multiplex laser light source as set forth in claim 1, wherein a block on which said plurality of semiconductor lasers are mounted is divided into a plurality of subblocks, and said subblocks are bonded together with one another.

5. The multiplex laser light source as set forth in claim 2, wherein a block on which said plurality of semiconductor lasers are mounted is divided into a plurality of subblocks, and said subblocks are bonded together with one another.

6. The multiplex laser light source as set forth in claim 3, wherein a block on which said plurality of semiconductor lasers are mounted is divided into a plurality of subblocks, and said subblocks are bonded together with one another.

7. The multiplex laser light source as set forth in claim 1, wherein said semiconductor lasers are GaN semiconductor lasers.

8. The multiplex laser light source as set forth in claim 2, wherein said semiconductor lasers are GaN semiconductor lasers.

9. The multiplex laser light source as set forth in claim 3, wherein said semiconductor lasers are GaN semiconductor lasers.

10. The multiplex laser light source as set forth in claim 4, wherein said semiconductor lasers are GaN semiconductor lasers.

11. The multiplex laser light source as set forth in

claim 1, wherein said multi-mode optical fiber has a core diameter of 50 μm or less and a numerical aperture of 0.3 or less.

12. The multiplex laser light source as set forth in claim 2, wherein said multi-mode optical fiber has a core diameter
5 of 50 μm or less and a numerical aperture of 0.3 or less.

13. The multiplex laser light source as set forth in claim 3, wherein said multi-mode optical fiber has a core diameter of 50 μm or less and a numerical aperture of 0.3 or less.

14. The multiplex laser light source as set forth in claim 4, wherein said multi-mode optical fiber has a core diameter of 50 μm or less and a numerical aperture of 0.3 or less.

15. The multiplex laser light source as set forth in claim 7, wherein said multi-mode optical fiber has a core diameter of 50 μm or less and a numerical aperture of 0.3 or less.

16. The multiplex laser light source as set forth in claim 1, wherein a value of (core diameter \times numerical aperture) of said multi-mode optical fiber is 7.5 μm or less.

17. The multiplex laser light source as set forth in claim 2, wherein a value of (core diameter \times numerical aperture) of said multi-mode optical fiber is 7.5 μm or less.

18. The multiplex laser light source as set forth in claim 3, wherein a value of (core diameter \times numerical aperture) of said multi-mode optical fiber is 7.5 μm or less.

19. The multiplex laser light source as set forth in claim 4, wherein a value of (core diameter \times numerical aperture) of said multi-mode optical fiber is 7.5 μm or less.

20. The multiplex laser light source as set forth in claim 7, wherein a value of (core diameter \times numerical aperture) of said multi-mode optical fiber is 7.5 μm or less.

21. The multiplex laser light source as set forth in claim 11, wherein a value of (core diameter \times numerical aperture) of said multi-mode optical fiber is 7.5 μm or less.

22. The multiplex laser light source as set forth in claim 1, wherein said plurality of semiconductor lasers comprise 3 to 10 semiconductor lasers arranged in a row.

23. The multiplex laser light source as set forth in claim 2, wherein said plurality of semiconductor lasers comprise 3 to 10 semiconductor lasers arranged in a row.

24. The multiplex laser light source as set forth in claim 3, wherein said plurality of semiconductor lasers comprise 3 to 10 semiconductor lasers arranged in a row.

25. The multiplex laser light source as set forth in claim 4, wherein said plurality of semiconductor lasers comprise 3 to 10 semiconductor lasers arranged in a row.

26. The multiplex laser light source as set forth in claim 7, wherein said plurality of semiconductor lasers comprise 3 to 10 semiconductor lasers arranged in a row.

27. The multiplex laser light source as set forth in claim 11, wherein said plurality of semiconductor lasers comprise 3 to 10 semiconductor lasers arranged in a row.

28. The multiplex laser light source as set forth in claim 16, wherein said plurality of semiconductor lasers comprise

3 to 10 semiconductor lasers arranged in a row.

29. The multiplex laser light source as set forth in claim 22, wherein said plurality of semiconductor lasers comprise 6 or 7 semiconductor lasers arranged in a row.

30. The multiplex laser light source as set forth in claim 1, wherein said plurality of semiconductor lasers each have a light-emitting width of 1.5 to 5 μm .

31. The multiplex laser light source as set forth in claim 2, wherein said plurality of semiconductor lasers each have a light-emitting width of 1.5 to 5 μm .

32. The multiplex laser light source as set forth in claim 3, wherein said plurality of semiconductor lasers each have a light-emitting width of 1.5 to 5 μm .

33. The multiplex laser light source as set forth in claim 4, wherein said plurality of semiconductor lasers each have a light-emitting width of 1.5 to 5 μm .

34. The multiplex laser light source as set forth in claim 7, wherein said plurality of semiconductor lasers each have a light-emitting width of 1.5 to 5 μm .

35. The multiplex laser light source as set forth in claim 11, wherein said plurality of semiconductor lasers each have a light-emitting width of 1.5 to 5 μm .

36. The multiplex laser light source as set forth in claim 16, wherein said plurality of semiconductor lasers each have a light-emitting width of 1.5 to 5 μm .

37. The multiplex laser light source as set forth in

claim 22, wherein said plurality of semiconductor lasers each have a light-emitting width of 1.5 to 5 μm .

38. The multiplex laser light source as set forth in claim 29, wherein said plurality of semiconductor lasers each have a light-emitting width of 1.5 to 5 μm .

39. The multiplex laser light source as set forth in claim 30, wherein said plurality of semiconductor lasers each have a light-emitting width of 2 to 3 μm .

40. The multiplex laser light source as set forth in claim 1, wherein said plurality of semiconductor lasers are arrayed and fixed two-dimensionally when viewed from a side where said laser beams are received.

41. The multiplex laser light source as set forth in claim 2, wherein said plurality of semiconductor lasers are arrayed and fixed two-dimensionally when viewed from a side where said laser beams are received.

42. The multiplex laser light source as set forth in claim 3, wherein said plurality of semiconductor lasers are arrayed and fixed two-dimensionally when viewed from a side where said laser beams are received.

43. The multiplex laser light source as set forth in claim 4, wherein said plurality of semiconductor lasers are arrayed and fixed two-dimensionally when viewed from a side where said laser beams are received.

44. The multiplex laser light source as set forth in claim 7, wherein said plurality of semiconductor lasers are

arrayed and fixed two-dimensionally when viewed from a side where said laser beams are received.

45. The multiplex laser light source as set forth in claim 11, wherein said plurality of semiconductor lasers are arrayed and fixed two-dimensionally when viewed from a side where said laser beams are received.

46. The multiplex laser light source as set forth in claim 16, wherein said plurality of semiconductor lasers are arrayed and fixed two-dimensionally when viewed from a side where said laser beams are received.

47. The multiplex laser light source as set forth in claim 22, wherein said plurality of semiconductor lasers are arrayed and fixed two-dimensionally when viewed from a side where said laser beams are received.

48. The multiplex laser light source as set forth in claim 29, wherein said plurality of semiconductor lasers are arrayed and fixed two-dimensionally when viewed from a side where said laser beams are received.

49. The multiplex laser light source as set forth in claim 30, wherein said plurality of semiconductor lasers are arrayed and fixed two-dimensionally when viewed from a side where said laser beams are received.

50. The multiplex laser light source as set forth in claim 39, wherein said plurality of semiconductor lasers are arrayed and fixed two-dimensionally when viewed from a side where said laser beams are received.

51. The multiplex laser light source as set forth in any one of claims 1 to 50, wherein said multi-mode optical fiber comprises a plurality of multi-mode optical fibers in which at least exit end portions thereof are disposed in one-dimensional array form, and each of said plurality of multi-mode optical fibers is combined with said plurality of semiconductor lasers and said light-collecting optics system.

52. The multiplex laser light source as set forth in any one of claims 1 to 50, wherein said multi-mode optical fiber comprises a plurality of multi-mode optical fibers in which at least exit end portions thereof are disposed in bundle form, and each of said plurality of multi-mode optical fibers are combined with said plurality of semiconductor lasers and said light-collecting optics system.

53. An exposure apparatus with a light source, wherein said light source comprises the multiplexer laser light source as set forth in claim 51.

54. An exposure apparatus with a light source, wherein said light source comprises the multiplexer laser light source as set forth in claim 52.